OYSTER MANAGEMENT AND RECOVERY STRATEGIC PLAN

Mississippi Department of Marine Resources

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The Mississippi Gulf Coast has historically been home to some of the nation's most productive and valuable oyster resources. The American oyster, *Crassostrea virginica*, is one of the most valuable natural resources of the United States and the Mississippi Gulf Coast which has been the source of livelihood for many generations of fishermen living in Mississippi. Many families continue to depend on Mississippi coastal waters and its rich, natural resources. Over the past 100 years, the oyster resource of the Gulf Coast has sustained a growing economy and has contributed greatly to the culture and heritage that defines Mississippi coastal natives.

Mississippi oysters provide many environmental benefits to the Mississippi Gulf Coast. Oysters are found in the shallow, estuarine waters of the Mississippi Sound. They can withstand intermittent changes in temperature and salinity which is a common occurrence in the Mississippi Gulf Coast. In addition to being a food source, oysters serve as a filter for the water system of the Mississippi Sound. Oysters are capable of filtering upwards of 50 gallons of water daily by consuming particles in the water and dispelling clean filtered water back into the environment. Oysters also provide natural habitats and nursery areas for other organisms that could also be a food source for other commercially valuable species. Oyster beds are also an important asset to prevent habitat erosion.

The Mississippi Department of Marine Resources (MDMR) Marine Fisheries Shellfish Bureau is dedicated to enhancing, protecting, and conserving the oyster resources of the Mississippi Sound. The Bureau has many goals and objectives which include working to increase harvestable oyster resources on public reefs, improving resiliency and adaptive management techniques to allow stakeholders and the resource to better withstand environmental and man-made stressors, improving water quality monitoring throughout the Mississippi Sound to recognize the quickly changing environmental conditions to the oyster fishery and incentivizing participation for on- bottom and off-bottom private-sector oyster production and harvest.

On February 2, 2015, Governor Bryant issued Executive Order 1350, creating the Governor's Oyster Restoration and Resiliency Council. The Oyster Council analyzed environmental/economic factors and influences on the oyster resource while exploring the role aquaculture and emerging technologies could play in growing the industry. Upon analysis of the factors and influences, the Oyster Council generated a report that made recommendations, for the restoration and resiliency of the oyster industry. By following the recommendations of this report, the State will reach the goals of increasing oyster harvest and creating new job and business opportunities while improving the environment through species recovery, habitat creation, and improved water quality.

Mississippi Department of Marine Resources - Mission Statement

The MDMR is dedicated to enhancing, protecting, and conserving marine interests of the state by managing all marine life, public trust wetlands, adjacent uplands, and waterfront areas to provide optimal commercial, recreational, educational, and economic uses of these resources consistent with environmental concerns and social changes.

The MDMR holds an important role in administering state and federal rules, regulations, and mandates such as: Mississippi Seafood Laws, the Mississippi Coastal Wetlands Protection Act, the Public Trust Tidelands Act, the Boat and Water Safety Act, the Derelict Vessel Act, the Non-Point Source Pollution Act, the Magnuson Act, the Wallop-Breaux Sportfish Restoration Act, and Marine Litter Act.

Management and Recovery Strategy

The Mississippi coastal environment encompasses an extensive, integrated array of ecosystems, habitats, and natural resources, which provide both recreational and commercial opportunities for residents and visitors. Mississippi's coastal and marine environment extends from the intertidal to the oceanic zones including estuaries, coastal streams, rivers, bays, the Sound, barrier islands, beaches, intertidal ecosystems, tidal and freshwater wetlands, and benthic environments. These habitats are rich sanctuaries of biodiversity and can influence the development and success of oyster resources. These habitats exist as the cultural fabric connecting the Mississippi Gulf Coast - economically, environmentally, and socially. Overall, the preservation and enhancement of the coastal environment is necessary to preserving the way of life in coastal Mississippi as the abundant water resources, and the natural ecological systems connected by them, underpin virtually all facets of life on the Gulf Coast.

Over the past decade, Mississippi's oyster resource has taken a hard hit and declined greatly due to several natural and man-made disasters. The decline in the oyster population across the Mississippi Sound has been devastating for many and continues to threaten to destroy the culture and heritage of oyster harvesting that once thrived in Mississippi. Without intervention, this resource may disappear from the Mississippi coastal waters.

The historic maximum acreage of the Mississippi public oyster reefs is estimated at 12,000 acres. In 2004, 491,000 sacks of oysters were harvested from Mississippi waters during a relatively normal season. Since then, the resource has endured devastating events such as Hurricane Katrina, the BP Oil Spill, and multiple Bonnet Carré Spillway openings, including a historic opening twice in one year. Industry representatives and MDMR marine scientists recommended that no oyster harvesting occur on wild reefs during the 2019-2020 season. Despite the outlook for current and future oyster seasons, Mississippi is positioned to become a Gulf of Mexico leader in oyster production. To get there, the State must develop, implement, and abide by a plan that incorporates current best practices and technologies for production, management, and conservation. By doing so, the State will reach its goals of increasing oyster harvest and creating new jobs and business opportunities while improving the environment through species recovery, habitat creation and cleaner water.

The marine and estuarine ecosystems and living resources of Mississippi are of considerable importance to the area's ecology and to the state's economy. Understanding where and how to effectively restore oysters and their protection is fundamental to restoration of the Mississippi Sound. There are several foundational questions that need to be addressed to ensure the end goal of sustainable oyster restoration is achieved. To enhance future oyster restoration efforts foundational questions about the type of bottom cultch materials, the profiles of existing reefs, the bearing strength and physical nature of sediments, and the influence of hydrodynamics need to be better understood.

Over the years, a tremendous amount of effort and funding have been put towards restoration efforts to improve Mississippi's oyster resource. MDMR is participating in multiple projects that improve and expand public reefs, promote aquaculture-based farming, restore living shorelines, promote new oyster growth, and help advance remote setting and hatcheries along the Mississippi Sound. This document will summarize these projects and will identify how each project will benefit the resource or environment. Projects are separated into three categories: 1) Active projects, 2) Future funded projects and 3) Future unfunded projects.

I. Management and Recovery Initiatives

Active Projects

A.	Oyster Cultch Early Restoration and Oyster Cultch Oversight	$270,752	Pg. 6
B.	Oyster Restoration and Management Phase I	$658,438	Pg. 6
C.	Oyster Reef Restoration	$125,000	Pg. 7
D.	Off-Bottom Oyster Aquaculture Program	$881,292	Pg. 8
E.	Remote Setting Facility Project – Phase I	$1,598,031	Pg. 9
F.	Shellfish Sanitation Compliance Program	$220,000	Pg. 10
G.	Off-Bottom Oyster Aquaculture Program	$120,000	Pg. 11
H.	Oyster Restoration Aquaculture Program	$123,000	Pg. 11
I.	Shellfish Water Quality Testing Laboratory	$760,000	Pg. 13
J.	Oyster Cultch Planting Program	$1,000,000	Pg. 13
K.	Oyster Plant – Spat-Tech	$3,000,000	Pg. 14
L.	Recruitment and Settlement Patterns of Oyster Spat	$19,374	Pg. 14
M.	Enhancement of the St. Louis Bay TNC Oyster Reef	$2,858,000	Pg. 15
	Total	$11,633,887	
N.	Restoring Living Shorelines and Reefs in Mississippi Estuaries		Pg. 15
O.	Oyster Shell Recycling Program		Pg. 16
P.	Permitting for the Expansion of Oyster Resources		Pg. 17

A. NRDA / MDEQ Oyster Cultch Early Restoration, Oyster Cultch Oversight

The Mississippi *Oyster Cultch Early Restoration* project is a Natural Resource Damage Assessment and Restoration Program (NRDA) which restores and enhances existing oyster reefs with cultch. This project has enhanced approximately 1,430 acres of the oyster cultch areas that cover approximately 12,000 acres of the Mississippi Sound. A total of 143,000 cubic yards of cultch material was deployed at a rate of approximately 100 cubic yards per acre. The project began in September 2012 and will be completed in early 2021.

Side scan sonar was utilized to identify potential cultch placement area as well as monitor cultch placements post deployment. Side scan sonar was also used for physical monitoring of reefs because of the ability to rapidly cover large areas and provide accurate measurements of coverage while simultaneously providing accurate GPS coordinates. Information acquired from side scan sonar provided a permanent record that will be used to detect changes over time due to environmental catastrophe, vessel groundings, and reef shifts.

B. NWFW / MDEQ - Oyster Restoration and Management Phase I

The National Fish and Wildlife Foundation (NFWF) *Oyster Restoration and Management* project includes several initiatives that provide decision makers with answers to enhance oyster productivity in the future. This project focuses on the key elements of oyster restoration: 1) Suitable substrate experimentation (75 acres), 2) Water quality mapping (530,000 acres), 3) Benthic habitat characterization (14,308 acres), 4) Hydrodynamic modelling of freshwater inflows (225,000 acres with connectivity to 56,285 acres) and 5) Oyster gardening program that will begin to add mature oysters (an estimated 210,000 grown and placed) back into the system, increasing spat recruitment. To underpin oyster restoration in Mississippi, the strategy of this phase of oyster-related projects is to address scientific gaps and root foundational causes that limit effective restoration, so that future oyster restoration will be successful and sustainable. Five experimental deployment sites have been identified for the oyster cultch deployment experiment including:

- Historic reefs located between the Bay St. Louis train bridge and Highway 90 bridge
- Historic reefs near the mouth of the Wolf River, N.E. quadrant of St. Louis Bay

- Reef on north shore of Deer Island, just south of Golden Nugget Casino
- Historic Biloxi Bay reef just north of Ocean Springs Bridge near “Fort Port”
- Historic Back Bay reef near Boomtown Casino

C. MDMR Tidelands Trust Fund – Oyster Reef Restoration

The primary goal of the *Oyster Reef Restoration* project is to restore and create oyster reefs within the vicinity of Biloxi Bay along with its bays, bayous, and tributaries where conditions are suitable for oyster growth and sustainability. The secondary goal is to identify the most effective and efficient cultch materials available to resource managers for oyster restoration.

Staff will assess suitability of specific areas within the proposed project location to identify potential restoration sites. Funds from this project will be used to acquire cultch materials, primarily oyster shell, which is in very limited supply, to accomplish the main restoration goal of this project. Staff will utilize the RV Conservationist and the Artificial Reef staging site on the industrial seaway in Gulfport to load and deploy different cultch types (oyster shell, limestone, crushed concrete, etc.) for the purpose of oyster reef restoration. Other innovative methods, such as deployment of oyster bags, remote setting of spat on cultch, use of engineered domes, etc. may be considered where feasible. Once material has been deployed for restoration, those sites will become part of the MDMR's annual Oyster Reef Assessment, and each site will be evaluated over time to monitor oyster growth, health, and performance of different cultch types as it relates to oyster restoration.

The primary objective of this project is to restore, create, and increase the area of public oyster reefs in the eastern Mississippi Sound. Secondary objectives are to test different cultch types and methods of restoration to determine the most effective and efficient available options for resource managers to increase oyster production, and to support those goals and strategies set forth by the Governor's Oyster Restoration and Resiliency Council for the recovery of MS's public oyster resources. A total of 7,692 cubic yards of oyster shell cultch was deployed on Biloxi Bay Reef and Henderson Point Reef.

D. RESTORE Act / MDEQ - Off-Bottom Oyster Aquaculture Program

Over the last decade, the decreased density of harvestable oysters has limited the number of oystermen engaged in the oyster industry along the Mississippi Sound. Diversifying the oyster industry by training oystermen and fishermen in off-bottom aquaculture was a direct objective of the Governor's Oyster Council Restoration and Resiliency report and will support and grow the oyster industry and the overall Mississippi economy. The RESTORE Act funded *Off-Bottom Oyster Aquaculture Program* has provided training in off-bottom oyster aquaculture operations, including business development and aquaculture methodologies, and will result in hands-on training on state-owned farms. Diversification of the oyster industry using off-bottom aquaculture techniques that use racks, cages, rafts, or longlines to grow oysters has proven to be very successful for enhancing workforce development and job creation.

The *Off-Bottom Oyster Aquaculture Program* addresses all aspects of off-bottom oyster farming appropriate to the local and regional area in oyster aquaculture operations, including business development and aquaculture methodologies. Participants will be positioned to operate and maintain economically and environmentally sustainable off-bottom oyster farms in the state of Mississippi, increasing the quantity and value of Mississippi's annual oyster harvest. MDMR established a two-phase off-bottom oyster aquaculture program, as well as offer post-program business incubation services. Phase I of the program includes classroom and field education on aquaculture, business operations and demonstrations of off-bottom aquaculture techniques. During this phase, participants receive the training and assistance needed to deploy and manage approximately 10,000 oysters with the use of MDMR rental equipment such as cages and bags as well as the MDMR small and large tube tumbler. During phase 2 of the program, training participants open their own off-bottom oyster aquaculture operations to continue training with instruction from the program to refine skills before beginning an individual operation.

The acreage of available off bottom leases has also increased from 2018 to 2021 in a total of three phases. Phase I included the ten-acre aquaculture training park and 75 acres available for commercial lease. In 2020, Phase II comprised of 135 additional acreage to the west of Phase I, providing commercial oyster farmers with a deep-water profile option as well as closer to the Biloxi Small Craft Harbor. In 2021, the final Phase III will be available to commercial farmers

which opens an additional 245 acres. Phase III is located north of Phase I and II, giving farmers the opportunity to farm in more shallow waters closer to Deer Island. In 2021, there will be a total of 465 acres available for commercial farming. The continuation of MDMR Off Bottom Oyster Aquaculture Program will allow aquaculture staff to train more farmers and lease out all acreage in approximately five to ten years.

E. RESTORE Act / MDEQ - Remote Setting Facility Project, Phase I

Remote setting is the placement of oyster larvae onto cultch at a remote location separate from the hatchery itself. This facility would assist in increasing the production of the natural oyster reefs along the Mississippi Gulf Coast. The remote setting facility is a critical component in the Governor's Oyster Council's blueprint for oyster restoration, as it will enable the MDMR to place cultch, laden with spat, at high volumes, into Mississippi waters which will support the increase of oyster populations on Mississippi's harvestable reefs and benefit the oyster fishery economy. This project will protect and restore living coastal and marine resources, promote community resilience, and restore, improve, and protect water resources.

The Shellfish Bureau has identified the Port of Gulfport Small Craft Harbor as the ideal location to situate the Remote Setting Oyster Facility. This location was selected for logistic efficiencies of cultch transportation into and out of the setting facility, the site's capacity to support the facility, optimal water quality conditions including salinity regimes, and an existing relationship with the Port of Gulfport for a pilot setting facility in the same location.

Staff have interviewed, selected, and contracted a private engineering firm to complete Phase I of the Remote Setting Facility Project. During Phase I, planning activities will be undertaken to assess the overall feasibility of the facility and determine infrastructure layout, as well as ongoing operational and maintenance costs. Phase I will produce a facility design that will have the capacity to receive five billion eyed larvae per year for remote setting with a productive use of space and acceptable culture methods to achieve optimal setting efficiencies and production milestones. The facility plans will also include an itemized list of equipment and supplies, staffing requirements for production, and projections of annual operational costs.

There are also many other design expectations that are part of Phase I other than the culture system. It will also involve the design of ergonomic ways to transport, load and unload large quantities of cultch material and spat on shell. Also, it will include a design for a robust pier to accommodate the docking and movement of cultch material on and off vessels.

Phase I is expected to be completed by December 31, 2021 and to be immediately followed by Phase II, construction, and start-up operations.

F. MDMR Tidelands Trust Fund - Shellfish Sanitation Compliance Program

Conducted within the guidelines of the Interstate Shellfish Sanitation Conference (ISSC) National Shellfish Sanitation Program (NSSP) Model Ordinance document, the Shellfish Sanitation Compliance Program determines the health of oysters by evaluating the quality of waters surrounding oyster reefs within the Mississippi Sound. Routine bacteriological samples ensure the sanitary control and safety of all oysters harvested for human consumption by commercial and recreational fishermen, the seafood industry, restaurants, and tourism. Illness associated with human consumption of raw or undercooked oysters stems primarily from elevated levels of bacteria from human and animal waste, called fecal coliforms, that are concentrated within oysters during the filter feeding process. These bacteria make their way to the oyster reefs through stormwater runoff, sewage overflow, domestic and wild animal waste, wastewater treatment plant failures, etc.

In addition to public safety, routine sampling provides insurance to shellfish managers that no new pollution sources are posing a threat to harvesting, preserving, and protecting oyster reefs which are one of Mississippi's key natural resources. The MDMR Shellfish Bureau regularly uses the information gained from the Shellfish Sanitation Compliance Program to properly classify the state's oyster growing waters in varying degrees of harvest and restrict harvest when conditions become unfavorable for human consumption. The objective of this project is to analyze seawater and oyster meat samples for management decisions on proper oyster harvesting throughout the year and for the annual evaluation of shellfish growing area classification by the Food and Drug Administration (FDA).

Bacteriological samples are collected once a month for all eight of Mississippi's oyster growing water areas throughout the year especially during colder months when fecal coliforms are more present. Sample sites are located throughout the Mississippi Sound and are primarily situated between the oyster reef and any potential pollution sources. Water samples are transported by MDMR personnel to an FDA certified laboratory where the analysis is performed. Once MDMR receives sample results, shellfish scientists analyze the data in comparison with environmental factors and historical data to correlate potential pollution sources and identify seasonal trends. In addition, the annual program evaluation completed by an FDA Shellfish Specialist uses the data collected from this program to monitor compliance of a food safety product with federally approved standards.

G. MDMR Tidelands Trust Fund - Off-Bottom Oyster Aquaculture Program

A critical component of any successful aquaculture project is the infrastructure behind the program. The MDMR has made substantial investments to install physical assets that will support the RESTORE Act, off-bottom oyster aquaculture program and will continue to support the expansion of aquaculture in state waters. Staff are committed to increasing the acreage at the Deer Island Oyster Aquaculture Park to 465 acres for Public Trust Tidelands Sub-leases and plans to develop aquaculture parks in each coastal county. Assuming the aquaculture park reaches maximum capacity, and each farmer is producing the minimum requirement of 100,000 oysters per acre, the Park could culture a minimum of 45 million oysters. In turn, the sales of 45 million oysters per year could profit upwards of 27.9 million dollars in revenue for commercial farmers. As of December 2020, MDMR has 48 acres leased which is only 11 percent of available space in the Aquaculture Park.

H. MDMR Tidelands Trust Fund - Oyster Restoration Aquaculture Program

The *Oyster Restoration Aquaculture Program* and its associated projects will contribute to increased oyster production and provide a more sustainable environment and habitat for Mississippi oysters. The purpose of this project is to increase the capacity of the Mississippi Oyster Restoration Partnership, Inc (MORP), which was a major recommendation of the

Governor's Oyster Council. Projects and programs are to be performed by MORP in partnership with MDMR and other agencies.

Currently, there is not a non-governmental entity to coordinate and implement related activities, projects, and programs. The State of Mississippi and its oyster resource will benefit by having a non-profit coordinating partner and MORP will seek to support other entities with common goals and missions which are to increase and enhance oyster production, education, outreach, and restoration in Mississippi waters. MORP will serve as a communication platform and coordinating entity for the implementation of many recommendations' activities related to oyster enhancement and restoration contained within the Governor's Oyster Council Report.

The programs associated with MORP include cultch planting, cultivation, relay, spat on shell, and the shell recycling. Cultch planting, cultivation, and relay will include the identification of associated site(s), permitting, coordination and procurement of labor and materials, as well as oversight of the deployment and processes. There is anticipation to recruit and utilize local commercial fisherman as volunteers for cultch planting, cultivation, and relay. Spat on shell development and deployment will comprise of remote setting of spat laden cultch materials and then transported to oyster reefs, seed grounds, and intertidal and subtidal areas. Finally, the shell recycling program involves outreach and identification of participants and creation and implementation of logistical arrangement with stakeholders. This project will propose an incentive program to educate/engage local stakeholders in the food, beverage, and gaming industries. In turn, this program will create a new source of shells which are currently and forecast to be scarce in supply. The shell recycling program would also include the development of a cultch loading dock or facility to help on-bottom oyster farmers move cultch from land to deployment vessels more easily. Development of this dock or facility will lead to increased safety as well as support other oyster projects along the Mississippi coast such as the *Oyster Gardening Program*.

I. GOMESA Phase II / MDMR - Shellfish Water Quality Testing Laboratory

The MDMR Shellfish Bureau was awarded a grant to build an FDA certified laboratory for continuous monitoring of the presence of fecal coliform indicator organisms in shellfish growing waters. The completion date for the new laboratory is expected to be January 2021. Having an FDA certified laboratory allows the state to be self-sufficient and cost effective. Outsourcing a critical component such as fecal coliform water analysis is not cost efficient. On average, the Shellfish Bureau collects roughly 1,000 water samples annually from water sample stations. These samples are also used to classify the state's oyster growing waters in varying degrees of harvest and restrict harvest when conditions become unfavorable for human consumption.

Per the NSSP Model Ordinance, the state authority must ensure that all samples are collected, maintained, transported, and analyzed in a manner to assure validity of analytical results in an FDA certified laboratory. Currently, the Shellfish Bureau completes all components of this requirement except for the laboratory analysis. This laboratory will allow for in-house analysis ensuring all requirements are met by MDMR staff. All data collected by an uncertified laboratory would be null and not accepted for use by the NSSP. Other uses for this project include the purchase of equipment and supplies for seawater analysis. Eventually, the state will expand on laboratory capabilities into other areas of marine monitoring. Funding for this project was awarded from the Gulf of Mexico Energy Security Act (GOMESA).

J. GOMESA Phase II / MDMR - Oyster Cultch Planting Program

The *Oyster Cultch Planting Program* restores and enhances oyster reefs through placement of cultch materials, such as crushed concrete, limestone, and/or cleaned oyster shells, in prime oyster habitats and other innovative oyster restoration and enhancement techniques. Cultch replacement and replenishment is a critical component of sustaining healthy oyster populations in Mississippi, especially given the recent environmental disasters that have impacted oyster resources in the state. The Shellfish Bureau will implement oyster restoration and enhancement projects on several thousand acres of suitable oyster habitat located in the Mississippi Sound.

K. GOMESA Phase II / MDMR - Oyster Plant - Spat-Tech

The primary goal of the development of an Oyster Plant is to deploy live oysters onto public reefs, resulting in the acceleration of oyster growth and harvesting. The oyster hatchery will use high-density oyster spat on shell technology that will introduce a large number of healthy oysters into the Mississippi Sound. The hatchery will be responsible for setting and growing oyster spat to a seed size of ⅜ to ⅝ inch average length totaling 60 million live seed oysters.

L. NOAA / MDMR - Recruitment & Settlement Patterns of Oyster Spat

Peak oyster spawning, typically occurring in the fall after a drop in water temperature, produces free-swimming larvae that attach to a hard material on the sea floor. These attached larvae are called spat and, over time, will grow to a harvestable size. To continue to fully replenish the State's reefs, there must be a better understanding of the spawning cycle of oysters throughout the year. Little is known about the spawning and settlement patterns of oysters during time periods not considered "peak" spawning season. There is evidence from recent sampling efforts that would indicate spat settlement is occurring in certain regions of the Mississippi Sound during the non-peak seasons.

Beginning in October 2020, Shellfish Bureau staff pinpointed multiple sites across the Mississippi Sound that historically showed high numbers of spat settlement and recruitment. These sites are located on reefs next to St. Louis Bay, Biloxi Bay, and Pascagoula Bay. Settlement plates deployed in these locations will be used to document spatial-temporal variation in spat settlement throughout the entire year of 2021. Every four weeks, staff will retrieve old plates, count all spat present, and deploy new settlement plates. This process will be repeated until the end of December 2021.

Determining localized oyster spawning trends will give the Shellfish Bureau insight into the prime locations and months to build and replenish the necessary reefs in the Mississippi Sound. The findings of this project will improve the effectiveness of oyster restoration on the Gulf Coast.

M. MDEQ / NFWF - Enhancement of the St. Louis Bay TNC Oyster Reef

The Nature Conservancy will conduct an enhancement project on an existing oyster reef in St. Louis Bay, Mississippi and expand the reef by 20 acres. Restoration will be accomplished through the deployment of cultch material at an existing 10-acre oyster reef site to add acreage and increase vertical relief. The vertical relief will ensure greater resilience to occasional incidents of low dissolved oxygen as well as enhance fisheries habitat. Commercial harvest in this part of St. Louis Bay is prohibited, leaving the reef available to produce spat and potentially support the rebuilding of other nearby oyster reefs. Planning for this project began in 2020 and construction is expected to begin early 2021.

N. NRDA / MDEQ - Restoring Living Shorelines and Reefs in Mississippi Estuaries

The NRDA funded Restoring Living Shorelines and Reefs in Mississippi Estuaries project includes the restoration of secondary productivity through the placement of intertidal and subtidal reefs and the use of living shoreline techniques including breakwaters. There are two overall goals of this restoration project: 1) construct breakwater structures to protect shorelines from erosion, to facilitate reef development, and to support secondary production, and 2) restore subtidal and intertidal reefs to support secondary production.

For this project, the living shoreline approach includes constructing breakwaters made of suitable manufactured and/or natural materials that reduce shoreline erosion by dampening wave energy while encouraging reestablishment of habitat that was once present in the region. Breakwaters would develop into reefs that support secondary productivity (living reefs). Subtidal and intertidal reefs would be built using suitable cultch material. A summary of the project locations and descriptions are below:

Graveline Bay Intertidal and Subtidal Reefs: Approximately two acres of intertidal reefs along the intertidal waterways of Graveline Bay will be restored. Approximately 70 acres of subtidal reef habitat would be restored in the nearshore environment of Graveline Bay.

Back Bay of Biloxi: Approximately 90 acres of subtidal reef habitat will be restored at locations in Back Bay of Biloxi and in the vicinity on the north side of Deer Island, adjacent to current reef projects.

Channel Island Living Shoreline and Subtidal Reef: Construction of approximately 2,385 feet of breakwater along the shoreline. Approximately 70 acres of subtidal reef habitat would be created and would connect the breakwater structure to an existing subtidal reef on the north and south sides of the island.

Big Island Living Shoreline: Construction of approximately 5,011 feet of breakwater along the southern facing shoreline directly adjacent to the navigation channel.

O. MDEQ / RESTORE Act - Oyster Shell Recycling Program

The *Oyster Shell Recycling Program* will support the restoration and protection of natural resources, ecosystems, fisheries, marine and wildlife habitats, beaches, and coastal wetlands of the Gulf Coast Region through the collection and utilization of discarded oyster shells for oyster cultch placement in the Mississippi Sound. Additionally, this program will include an economic sustainability analysis.

Shell recycling programs have been implemented throughout the coastal United States to reuse discarded oyster shells from restaurants, festivals, and other venues. The program objective is to avoid discarding oyster shells by collecting them from these venues and reusing them as cultch material for oyster reefs in the future. However, all oyster shell recycling programs from Maryland to Louisiana must consider mechanisms to ensure that the program can be sustainable after an initial start-up period. Thus, it is imperative to conduct an economic sustainability analysis that will determine the potential number of shells available for re-use across the spectrum of sources in the area, evaluate costs of hauling, storing, and deploying shell, and inform the economics of the program for viability and sustainability.

While the MDMR is not directly associated with the program we support the efforts and will assist with identifying oyster reefs that will benefit from the project.

P. Permitting for the Expansion of Oyster Resources

The Shellfish Bureau has many priorities, but stock enhancement and commercial production are core to our mission. We feel that the restoration of Mississippi reefs is vital to the success of the industry and we encourage using water bottoms for public/private reef enhancement, identifying and development of new off-bottom aquaculture areas and the study of best emerging technologies to implement programs for economic and environmental purposes.

In 2015, MDMR submitted an application to restore historic oyster resources across the MS Sound within the State waters of Mississippi, specifically in the western MS Sound. Final authorization was completed in 2017 after a thorough review process. The purpose of that project was to restore the valuable public oyster resources for the benefit of the stakeholders of State of Mississippi and to enhance the marine environment along the MS Gulf Coast. Implementation of Phase I of that project began immediately and to-date approximately 880 acres of oyster reef have benefited from oyster restoration activities and had begun the process of recovery.

This remains the focus of this proposed project. However, since the process for the last permit began, the Federally operated Bonnet Carré Spillway has been opened multiple times by the United States Army Corps of Engineers (USACE) causing significant loss to the marine resources of the MS Gulf Coast, especially oysters in the western MS Sound. Because the majority of the historic oyster reefs that are part of the existing permit are located in the western MS Sound and directly in the path of the waters released through the Bonnet Carré Spillway (BCS), State resource managers believe there is too much uncertainty surrounding the sustainability and viability of maintaining healthy oyster populations in this region of the MS Sound to continue to invest heavily in restoration efforts and, instead, have decided to shift focus to areas further east. For this reason, it appears the more viable resource management option is to restore historic areas and expand oyster resources in Harrison and Jackson Counties, which is much further from the direct impacts caused by the frequent opening of the BCS.

This project will identify and apply with USACE and MDMR to restore and create approximately 2,524 acres of oyster reef in Biloxi Bay and expand the current footprint of the MDMR Commercial Aquaculture Parks to Harrison and Jackson counties. Restoration and creation of oyster reefs will improve water quality within the areas of the reefs, create valuable

near shore reef habitat that will support and sustain healthy populations of estuarine fish and other invertebrates, and enhance recently completed and future proposed restoration areas on the eastern end of Deer Island in Harrison County, MS and along the MS Gulf Coast.

II. Management and Recovery Initiatives

Future Funded Projects

A.	Pascagoula Oyster Reef Complex Relay and Enhancement	$4,100,000	Pg. 18
B.	Oyster Spawning Reefs in the Mississippi Sound	$10,000,000	Pg. 18
C.	Remote Setting Facility Project – Phase II	$7,700,000	Pg. 19
D.	Restoration of Mississippi's Oyster Reefs	$5,000,000	Pg. 20
E.	Expansion and Enhancement of Oyster Aquaculture in MS	$1,566,380	Pg. 20
F.	Investigation of Pollution within Shellfish Growing Waters	$287,650	Pg. 21
G.	Development of a Shellfish Harvester Training Video	$75,000	Pg. 22
H.	Off-Bottom Oyster Aquaculture Program	$1,457,395	Pg. 23
	Total	$30,186,425	

A. MDEQ / RESTORE Act - Pascagoula Oyster Reef Complex Relay and Enhancement

The *Pascagoula Oyster Reef Complex Relay and Enhancement Project* will support the restoration and protection of Mississippi's coastal resources by relaying oysters from the Pascagoula Oyster Reef Complex (PORC) to harvestable areas and enhancing the PORC. The oyster restoration and management project may include benthic habitat mapping, reef monitoring, and relay of oyster resources to increase productivity on harvestable reefs.

Oyster restoration and management is critical to enhancing ecosystem functionality and the integrity of bays and estuaries within the Mississippi Sound. This proposed project will restore, enhance, and replenish oyster populations on the PORC through increased understanding of oyster reef habitat acreage and volume, creating a scientifically based oyster relay program to maximize sustainable oyster production, and monitoring production on the reef throughout time to adjust relay program targets for sustainable take and production.

Initial assessment and annual monitoring of existing PORC will create estimates of the number of oysters by size class and allow annual projections of oyster sacks to be moved through the oyster relay program. The PORC relay program will maximize the sustainable harvest (through monitoring data) and the transfer of harvestable size class oysters from the Pascagoula ORC to open harvest-growing waters in the Mississippi Sound.

B. MDEQ / NRDA - Oyster Spawning Reefs Project

The *Oyster Spawning Reefs Project* will result in creation and restoration of high-relief cultch placements within the Mississippi Sound located in Hancock, Harrison, and Jackson Counties. Oyster restoration will include a minimum of 100 acres and a maximum of 400 acres of subtidal reefs. Creation and restoration of the reefs will include siting reefs, design, and cultch deployment. These actions will help restore oyster habitats in Mississippi injured by recent natural and man-made disasters. The anticipated timeframe for oyster restoration activities will be 10 years.

C. MDEQ / RESTORE Act - Remote Setting Facility Project – Phase II

At the completion of Phase I, *Remote Setting Facility* planning, the budget and scope for startup costs will have been developed and will then enter Phase II, Construction and Start Up Operations. Phase II will aim for construction of the remote setting facility and procurement of necessary equipment and will be based on the planning activities, engineering and design specifications developed in Phase I.

The purpose of the *Remote Setting Facility Project* is to support the restoration and protection of natural resources, ecosystems, fisheries, marine and wildlife habitats, beaches, and coastal wetlands of the Mississippi Gulf Coast Region through the planning, construction, and operational activities associated with a *Remote Setting Facility Project*. This project will protect and restore living coastal and marine resources, promote community resilience, and restore, improve, and protect water resources. The remote oyster setting facility would be complementary to the University of Southern Mississippi (USM) Oyster Hatchery. Larvae produced within the

USM Oyster Hatchery would be transported to the *Remote Setting Facility Project* and placed on cultch materials.

The expectation for this facility will be to receive five billion oyster larvae from USM to set on shell and eventually be planted on local reefs within the Mississippi Sound during the months of May through November. Production and setting efficiencies will be optimized using best available science and scientific expertise and testing. MDMR estimation based on the historical setting efficiency at the Gulfport location is 15 percent. Therefore, 750 million spat will be set on approximately 52 million individual shells each year of production for the *Remote Setting Facility Project*.

The spat on shell produced at the facility will be deployed at oyster growing sites deemed appropriate by the MDMR Shellfish Bureau. Short term benefits of this project will include immediate increase in oyster abundance and the reproductive potential in specific areas. Long term benefits will include increase in oyster productivity, resilience, and stabilization of reef locations for future harvesting.

D. Bonnet Carré 2019 Fisheries Disaster Recovery Program – Restoration of Mississippi Oyster Reefs

This project will provide for the restoration for existing oyster reefs as well as the creation of new oyster reefs in the Mississippi Sound. The deployment of approved oyster cultch material will take place over a five-year period on suitable water bottoms in the three coastal counties with the majority of the effort in the Western Mississippi Sound where the most recent assessment indicates the need is greatest. This cultch planting project is estimated to cover as many acres of water bottoms with cultch material (limestone, crushed concrete, and oyster shell) as needed for a successful oyster spat set. Cultch planting rates may be adjusted to maximize benefits specific for each area. Cultch planting may also be conducted in areas with historically high spat sets but lower long-term survival (e.g., high salinity areas), with the purpose of moving or relaying those juvenile oysters into areas with higher growth and survival rates (e.g., moderate salinity areas).

E. Bonnet Carré 2019 Fisheries Disaster Recovery Program – Expansion and Enhancement of Oyster Aquaculture in Mississippi

The oyster industry in the Mississippi Sound is currently limited to a small number of off-bottom leaseholders and public harvestable reefs. Decreased density of harvestable oysters has limited the number of oystermen engaged in this economic sector. Diversification of the oyster industry using off-bottom aquaculture techniques such as racks, cages, rafts, or longlines to grow oysters has proven very successful for enhancing workforce development and job creation in Mississippi and other Gulf states. Currently, there are two main challenges for the oyster farming industry: 1) a need to scale-up farm operations and, 2) a need to increase productivity and reduce labor costs. This program will spend significant time identifying, troubleshooting, and solving these issues for Mississippi oyster farmers. This project will develop solutions unique to the local area and geographic limitations and will focus on the two previously mentioned aspects of the growing industry using new technologies to identify methods that streamline cultivation activities, increase distribution, and ultimately expand the off-bottom oyster industry.

This project will also establish a grant and/or loan program to incentivize stakeholders to participate in off-bottom oyster aquaculture. Funds distributed to stakeholders could be used to purchase equipment, cultch materials, or assist in the permitting process which would incentivize more participation and long-term private investment in off-bottom oyster aquaculture. This program would provide affordable financing to fishermen and other parties who want to start or expand commercial shellfish aquaculture operations in Mississippi.

F. Bonnet Carré 2019 Fisheries Disaster Recovery Program – Investigation of Pollution within Shellfish Growing Waters

Many waterbodies across the Mississippi Sound, suitable for growing wild and aquaculture oysters, are currently classified as restricted or prohibited for oyster harvest due to poor water quality conditions. These poor conditions are often related to high fecal coliform load. An increase in fecal coliform levels found in marine environments may be an indication of contamination from wastewater or sewage. This bacterium usually enters waterways by:

discharge of human sewage directly into a waterbody; failing wastewater infrastructure or home septic systems; an increase in waste from mammals and birds; agricultural practices such as livestock grazing near waterways, or using manure as fertilizer; runoff from storm drains, parking lots or yards which carry pet waste to nearby streams and tributaries; etc.

Staff have identified locations across the Mississippi Sound that currently are unsuitable for reclassification due to poor water quality conditions. The purpose of these investigations is to locate the source of historically high fecal coliform levels within several smaller, nearshore waterbodies across Mississippi's coastline. By homing in on smaller water outlets, staff can work to pinpoint the source(s) of pollution contributing to localized poor water quality. Once these sources are identified, staff will work with local municipalities to develop strategies for mitigation and decrease fecal loads. When water quality improves, several areas can be reclassified across the Mississippi Sound enabling the MDMR to expand and grow the on-bottom and off-bottom oyster industry. In addition, this effort will improve water quality conditions and remove human contribution of contamination.

The chosen areas will be evaluated prior to the field investigation. Staff will compare historical fecal coliform data with river stages, rainfall levels, tides, current patterns, wind direction and velocity, and seasons to determine if there are any environmental correlations.

Field investigations will consist of two parts. First, staff will visit city administrations to discuss the wastewater infrastructure near the area of concern, locate all lift stations and wastewater treatment centers, and drive the area for signs of sewage failures and infrastructure problems. Second, the sampling investigations will consist of four phases throughout the year in which staff will correlate sample times with tides and weather. To ensure rainfall does not influence the sample results, the sample regime will be conducted during dry conditions. Samples will be collected periodically through a 12-hour tidal cycle. Along with each phase of the investigation, a tidal current study will be conducted to show the direction of flow of water from the potential pollution source.

Once these sources are identified, staff will work with local municipalities to develop strategies to mitigate and decrease fecal loads. When water quality improves, areas can be reclassified across the Mississippi Sound allowing the MDMR Shellfish Bureau to develop additional oyster aquaculture farms for oyster harvesters. On top of increasing the economic success of

Mississippi's oyster fishery, this effort will improve water quality conditions and remove human contribution of contamination.

G. Bonnet Carré 2019 Fisheries Disaster Recovery Program – Development of a Shellfish Harvester Training Video

In 2014, the ISSC set forth the requirement that all states with shellfish harvest must offer an educational training program to oyster harvesters. The training includes shellfish sanitation requirements, safe harvesting, handling, and transportation methods, etc. This program is required as a prerequisite to receiving a commercial oyster harvester license and the training certificate must be renewed every five years. The development of a training video will offer a thorough, concise, and consistent training session to all oyster harvesters and will allow for remote access to the training session. In addition to the training, harvesters should receive the materials needed to complete the trip ticket and tags in the field with consideration of adverse environmental conditions.

H. GOMESA 2021 – Off-Bottom Oyster Aquaculture Program

Among the many challenges to raising oysters is discovering how they grow in specific environments. Different parts of the world use different types of gear for oyster aquaculture to contain and grow oysters depending on wind, waves, tidal fluctuation, temperature, and local regulations. Finding the right gear for a particular farm could become a costly exercise in trial and error. Through this project, Shellfish Bureau staff will build a demonstration facility that will help oyster farmers test new gear and techniques in hopes of expanding the states oyster industry.

A demonstration facility will allow farmers to test new equipment, combine resources and streamline efficiencies so oyster farmers do not have to absorb the risk alone. As oyster farmers face a diverse array of challenges, this program hopes to address those issues and have meaningful impacts to help grow the oyster aquaculture industry.

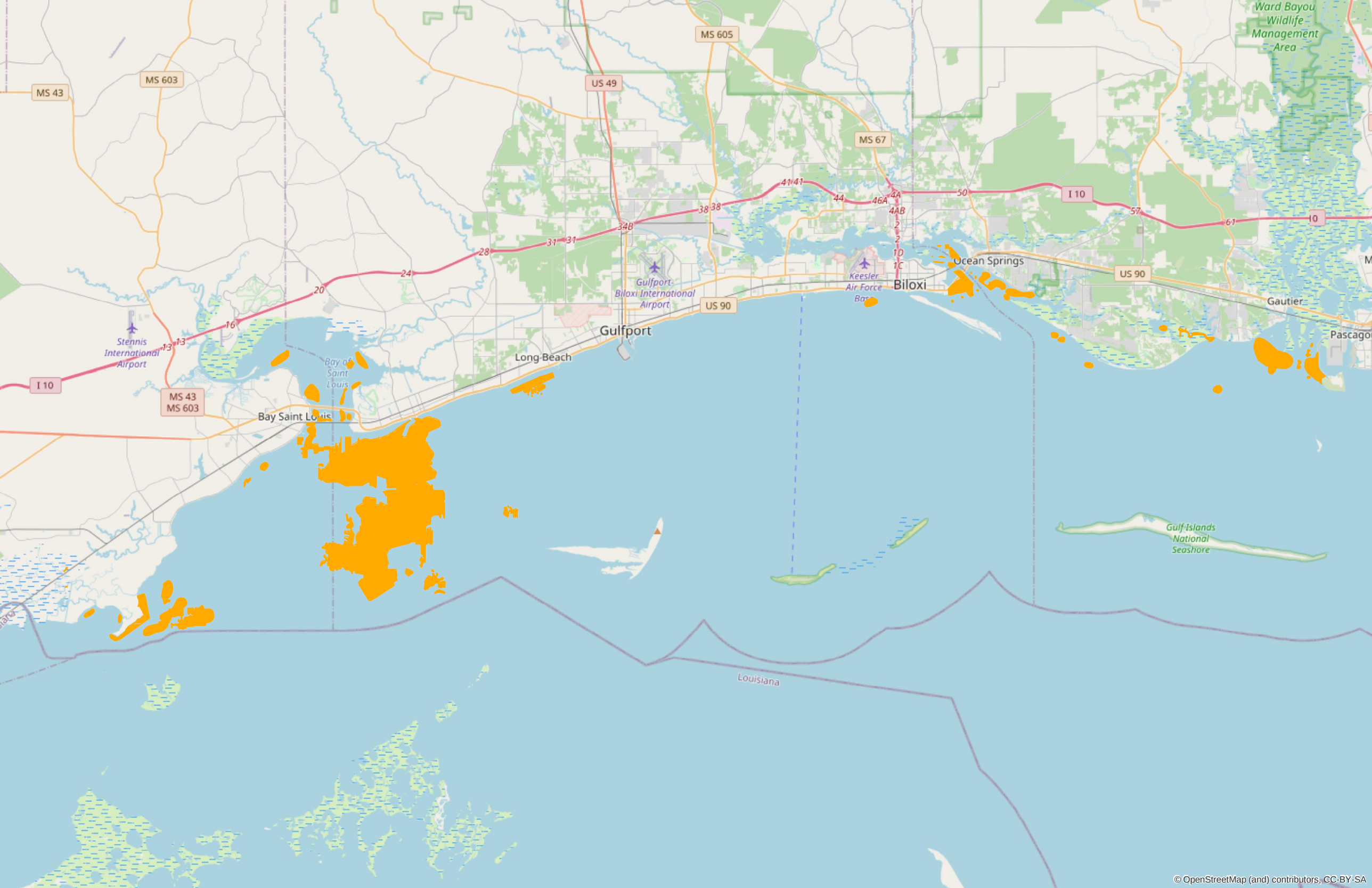
A.	Cultch Planting	$20,000,000
B.	Cultivation of Suitable Oyster Reefs	$5,000,000
C.	Assist Coastal Municipalities with Upgrading Faulty Sewer Systems	$2,000,000
D.	Incentivize Diploid Production for Oyster Aquaculture	$5,000,000
	Total	$32,000,000

A. Cultch Planting

Cultch planting restores and enhances oyster reefs through placement of cultch materials, such as crushed concrete, limestone, and cleaned oyster shells, in prime oyster habitats and other innovative oyster restoration and enhancement techniques. Cultch replacement and replenishment is a critical component of sustaining healthy oyster populations in Mississippi, especially given the recent environmental disasters that have impacted oyster resources in the state. MDMR Shellfish Bureau plans to implement a large-scale oyster restoration and enhancement project with the assistance of a private contractor to provide and deploy cultch materials in several of the thousands of acres of suitable oyster habitat located in the Mississippi Sound. Upon completion, this project will restore and enhance over 300 acres of oyster habitat and produce upwards of 30 million live oysters. This project is projected to be funded through GOMESA for 20 years in the amount of $1,000,000 per year for a total of $20,000,000. Program requirements will be determined upon approval.

B. Cultivation of Suitable Oyster Reef

Cultivation of oyster reefs is the process of tilling non-viable reefs to expose hard substrate for spat settlement and to sufficiently clean sediment and unwanted organisms from the reef material. This project would employ Mississippi oystermen to cultivate suitable oyster reefs using a bagless dredge. Used by many fishermen, a dredge is a tool with a strong frame holding



up a chain metal bag. Attached to the lower lip of the frame are multiple metal teeth. The oystermen tow the dredge slowly behind their boat while the teeth dig into the top layer of the reef, filling the bag with the fisherman's catch. During cultivation, however, the absence of the bag means the reef material is turned over and not taken from the reef.

In 2021, results from the project titled *'Recruitment and Settlement Patterns of Crassostrea virginica on Oyster Reefs in the Mississippi Sound'* will be available to determine when to avoid reef cultivation for natural spat set. The results will emphasize which reefs are producing more spat and will allow staff to plan accordingly to maximize reef cultivation. Secondary beneficial purposes include breaking up clusters of oysters for a more even distribution of the reef, and to help reduce hooked mussel infestations. Proposed areas of cultivation include the Eastern and Western Mississippi Sound reefs. This project is projected to be funded through GOMESA and is estimated at $5,000,000. Program requirements will be determined upon approval.

C. Assist Coastal Municipalities with Upgrading Faulty Sewer Systems

Sanitary surveys are conducted annually by the Shellfish Bureau to pinpoint new sources of pollution to the Mississippi Sound and assess the condition of wastewater treatment plants, city sewer systems, and single home septic tanks. The final report is analyzed by an FDA Shellfish Specialist who determines the overall health risk of Mississippi grown oysters sold to the public. The goal is to ensure a clean coastline with little pollution as possible. Unfortunately, through these surveys, the Shellfish scientists have documented many failing lift stations, overflowing manhole covers, and sewer and septic leaks into the Mississippi Sound.

These are problems that can be fixed through specific projects that aim to mitigate human waste pollution found in the oyster growing waters. The Shellfish Bureau intends to assist each municipality with direct influence on an oyster reef to find the appropriate funding to fix these commonly seen problems. A designated team will work with coastal municipalities to secure necessary funding and see the project through to completion. This work has the potential to open currently restricted areas to harvest and pave the way in building additional oyster aquaculture parks and replenishing historical habitats for future healthy and productive oyster reefs. This

project is projected to be funded through GOMESA and is estimated at $2,000,000. Program requirements will be determined upon approval.

D. Incentivize Diploid Production for Oyster Aquaculture

Most off-bottom farmers have chosen to incorporate “triploid” oysters into their farms, in part because they are sterile and thus remain plump and firm through the summer season, when other oysters spawn. Because triploid oysters do not expend energy producing gametes, they can grow more quickly and reliably throughout the season. While this is beneficial for off-bottom farmers it does not provide additional stock enhancement for the public oyster reefs in Mississippi. Diploid oysters are crucial to spat production, recruitment and long-term viability of on-bottom oyster reefs.

In partnership with the Mississippi Development Authority (MDA), the MDMR would like to provide affordable financing to oyster farmers and other parties who want to start or expand commercial shellfish aquaculture operations in Mississippi but also want to ensure the sustainability of our public oyster reefs. Through this proposed program, the borrowers would agree to grow 15 percent of crops as diploid oysters that would be deployed on the wild reefs in Mississippi. Oyster farmers would make interest-only payments, initially at 1.5 precent, for the first three years. If borrowers make their quarterly payments, 60 percent of the principal balance will be forgiven, and borrowers will repay the remaining balance over two to four additional years. The maximum single loan amount is $400,000. Loan proceeds may be used to start an oyster nursey, oyster hatchery, or purchase shell, seed or spat for farm operations. This project is projected to be funded through GOMESA and MDMR Tidelands Program and is estimated to cost $2,000,000. Program requirements will be determined upon approval.

Conclusion

Currently, the MDMR has sixteen (16) active projects totaling $11,633,887, eight (8) future funded projects totaling $30,186,425 and four (4) future unfunded projects totaling $32,000,000.

If all projects were to be funded, we would have 28 projects that totaled approximately $73,820,312. The MDMR has made a substantial commitment to participate in the projects listed in this document. We believe that through these projects, our agency can and will expand public reefs, promote aquaculture-based farming, restore living shorelines, promote new oyster growth and help advance remote setting and hatcheries along the Mississippi Sound.